INTER-OFFICE CORRESPONDENCE

To: C.C. Henningson Date: 7/21/82

From: S.A. Roberts SAR

Subject: Waukegan Harbor Slip #3-PCB Loading Rates

The potential PCB loading rates of ground water discharging through Slip #3 have been evaluated using two scenarios:
Scenario #1: The slip filled with clean sand.
Scenario #2: The slip with dredged material from adjoining areas of the harbor.

In order to estimate the ground-water flow and PCB loading rates, the following assumptions were made:

1. The bulkhead is not acting as an effective barrier to ground-water flow; i.e. there is leakage through the bulkhead.

2. Ground water is probably not moving under the bulkhead; since vertical flow components are probably negligible due to the lower permeability clay materials (See Figure 1).

3. Ground water movement is into the slip and there is no movement from the slip into adjoining areas.

4. Filling-in of the slip will create an "artificial aquifer" resulting in ground-water flow in a east-southeast direction. (See Figure 2)

5. A hydraulic gradient (I) of 0.001 ft/ft was assumed for this site; this is a typical value for areas of low relief. At the OMC site, the observed hydraulic gradient is 0.0007 ft/ft.

6. The hydraulic conductivity values (K) of the material are assumed to be:
   - clean sand = 5×10^{-3} cm/sec
   - in-situ sand = 5×10^{-4} cm/sec
   - muck = 5×10^{-5} cm/sec
   - dredged material (mixture of sand and muck = 1×10^{-4} cm/sec

These values are based on the following: 1: expected K values for similar sediments, and 2: values listed in Freeze + Cherry, Groundwater pg. 29.

3. The area at the mouth of the slip = 6,000 ft^2. This is based on a 20 ft. depth (PCB report) and a 300 ft. width (Albany Office - verbal communication).

Information gathered on the mobility of PCBs must also be addressed before estimates of PCB loading rates can be made.

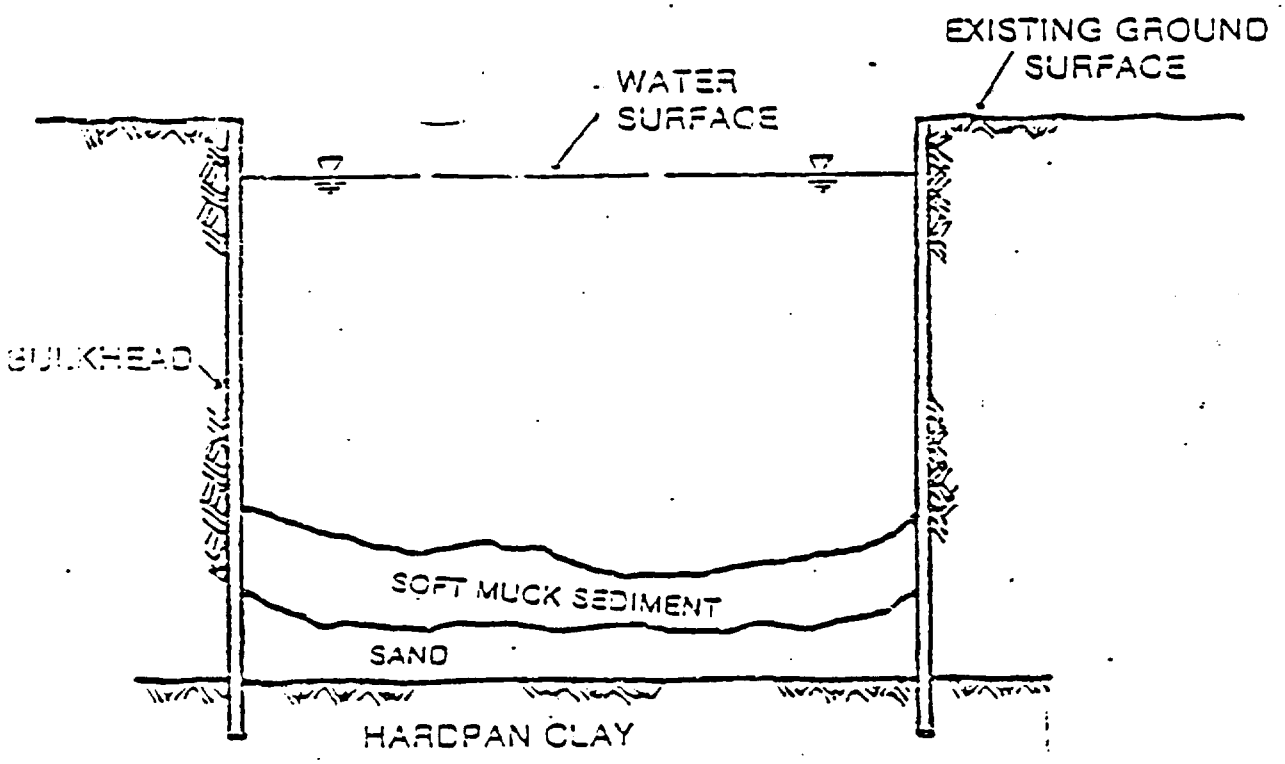


FIGURE 1

CROSS-SECTION OF SLIP #3

1. PCBs are normally tightly bound to soil material with a high organic content.

2. PCBs are "infinitely" soluble in hydrocarbon solvents and in chlorinated solvents. (Monsanto-verbal communication).

3. PCBs desorb completely in the presence of nonpolar solvents, i.e. adsorption = 0.

4. The higher the amount of chlorination of PCBs, the lower the desorption rate.

5. The addition of water affects the behavior of solvents in some way; it probably reduces desorption rates of PCBs, but the rate and amount of desorption is dependent upon the type of solvent and its concentration, the type of soil, the type(s) of PCBs, and other factors. Information on specific desorption rates and amounts is probably only available through actual testing: soil columns, etc. Predictions cannot be made with any degree of certainty.

6. PCBs can move in ground water while adsorbed onto colloidal material (SP Maslansky - verbal communication); this movement can be a significant source of contamination; actual rates and amounts cannot be quantified without testing.

Sources of information not specifically cited are from Bob Griffin, Illinois Geological Survey-verbal communication, and Carter Knowlton and Leon Adams, Southwest Research Institute - verbal communication.

Based on the assumptions and information outlined above, the estimated ground-water discharge and loading rates are:

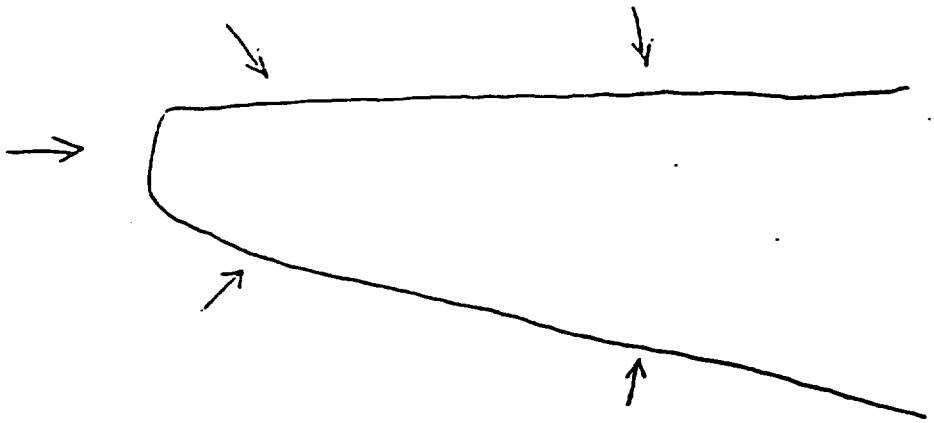
Ground-Water Discharge (Q)

Scenario #1

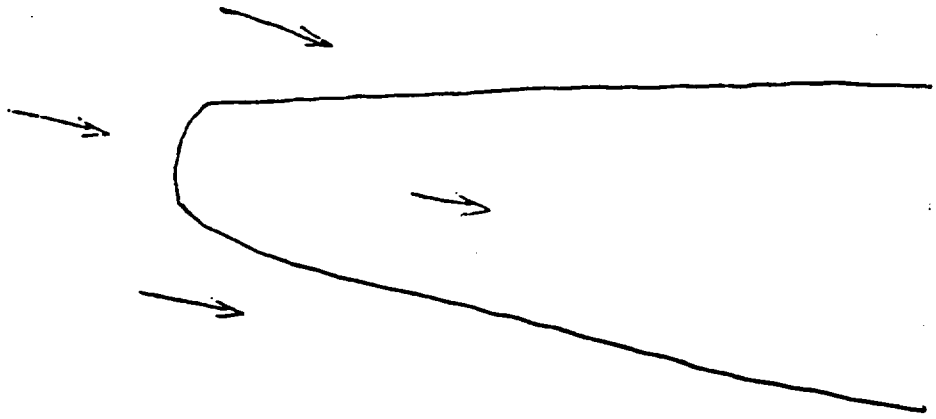
Material	K, cm/sec	I, ft/ft	A, ft	Q, ft^3/day
Clean sand	5×10^{-3}	0.001	10 x 600	43
In-situ sand	5×10^{-4}	0.001	5 x 600	2
Muck	5×10^{-5}	0.001	5 x 600	0.2

Scenario #2

Dredged material	1×10^{-4}	0.001	10 x 600	1
In-situ sand	5×10^{-4}	0.001	5 x 600	2
Muck	5×10^{-5}	0.001	5 x 600	0.2



1. BEFORE FILL-IN



2. AFTER FILL-IN

EXPLANATION

→ EXPECTED GROUND-WATER FLOW DIRECTION

FIGURE 2

EXPECTED CHANGES IN GROUND-WATER FLOW:

SLIP #3

Loading Rates

Each of the scenarios were evaluated in two ways.

1) Loading rates were estimated on the assumption that there are no solvents or colloids in groundwater. This assumes that desorption will occur to the limits of the PCB solubility and then equilibrium will be reached. A PCB solubility value of 200 ug/l, was used for the calculations (based on values given by Bob Griffin). Loading rates were calculated using the discharge rates listed in the previous section times this PCB solubility value.

- Clean sand (PCB source is groundwater) = 0.0005 lbs/day
- In-situ sand (PCB source is groundwater or sediment) = 0.00002 lbs/day
- Muck (PCB source is groundwater or sediment) = 0.000002 lbs/day
- Dredged material (PCB source is groundwater or sediment, PCB concentration in sediment assumed to be 100 ppm) = 0.00001 lbs/day

Scenario #1: Clean sand + sand + muck = 0.0005 lbs/day
Scenario #2: Dredged material + sand + muck = 0.00003 lbs/day
(Figures 3-A and 3-B show the loading rates for each scenario.) If there are no solvents and/or colloids present, these represent a worst-case condition.

There is a possibility that solvents and/or colloids may be present in the ground water since elevated levels of PCBs were found in monitoring wells at the OMC site. This could cause a higher PCB loading rate in the ground water.

A more reasonable evaluation of a possible range of loading rates could be arrived at after a detailed field/laboratory investigation. The numbers developed above represent, at best, rough estimates of a possible range of loading rates.

Closing Comments

1. A more definitive assessment of ground-water flow conditions near Slip #3 would require the installation of several nested piezometers in the vicinity of the slip. Information obtained from water-level measurement and permeability tests would be used to define the vertical/horizontal flow components and flow rates.

2. Water samples taken from the nested piezometers could be analyzed for solvent content and presence of colloids.

3. In addition, soil columns or similar tests with site material could be run to determine more clearly the desorption potential of PCBs at this site.

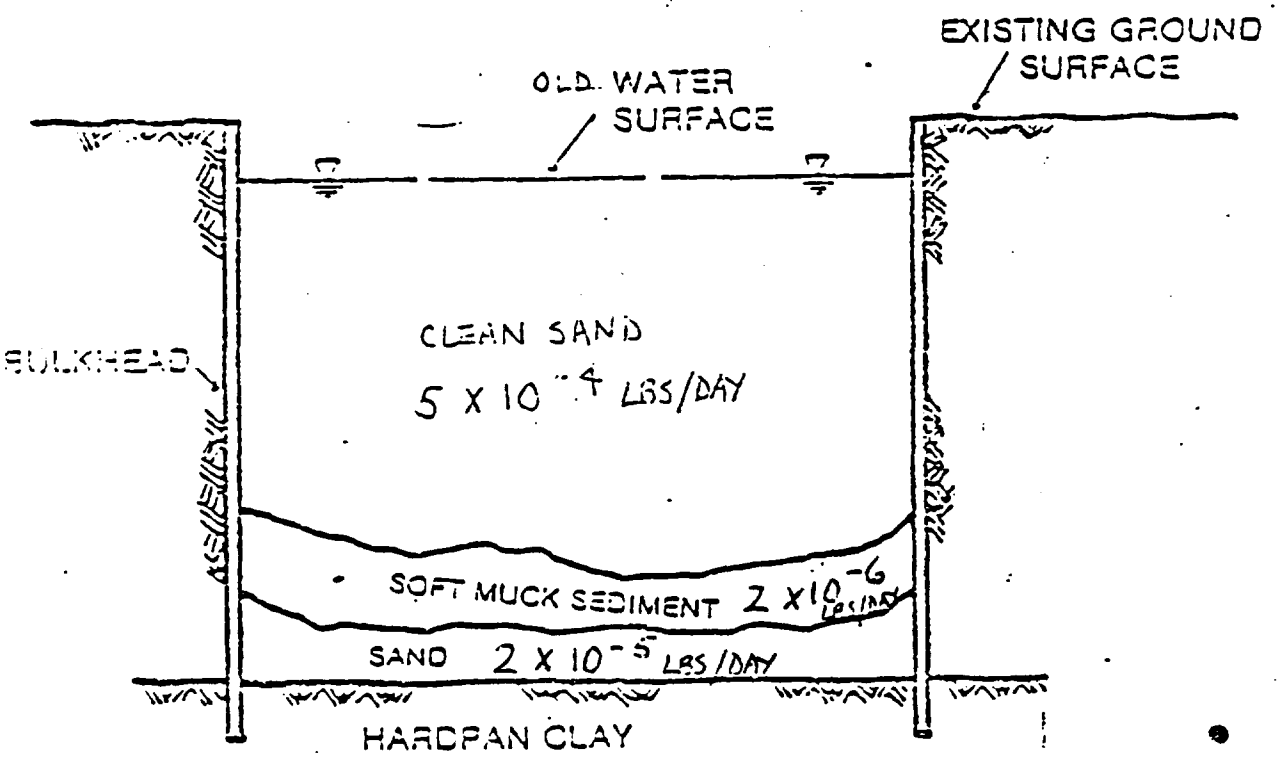


FIGURE 3-A

SCENARIO #1

PCB LOADING RATES

TOTAL LOADING : 5×10^{-4} LBS/DAY

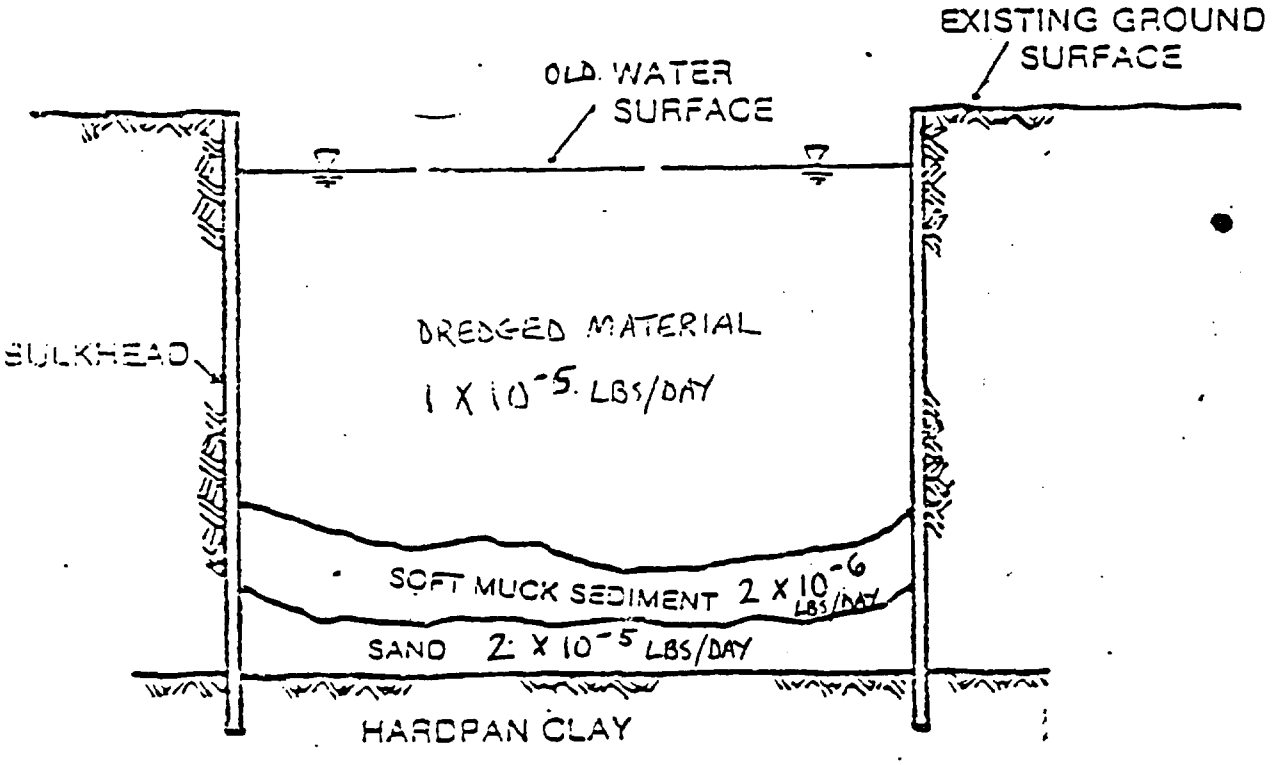


FIGURE 3-B

SCENARIO # 2

PCB LOADING RATES

TOTAL LOADING : 3×10^{-5} LBS/DAY